Anesthetic Efficacy of Buccal and Lingual Infiltrations of Lidocaine Following an Inferior Alveolar Nerve Block in Mandibular Posterior Teeth

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The authors, using a crossover design, randomly administered, in a single-blind manner, 3 sets of injections: an inferior alveolar nerve block (IANB) plus a mock buccal and a mock lingual infiltration of the mandibular first molar, an IANB plus a buccal infiltration and a mock lingual infiltration of the mandibular first molar, and an IANB plus a mock buccal infiltration and a lingual infiltration of the mandibular first molar in 3 separate appointments spaced at least 1 week apart. An electric pulp tester was used to test for anesthesia of the premolars and molars in 3-minute cycles for 60 minutes. Anesthesia was considered successful when 2 consecutive 80 readings were obtained within 15 minutes following completion of the injection sets, and the 80 reading was continuously sustained for 60 minutes. For the IANB plus mock buccal infiltration and mock lingual infiltration, successful pulpal anesthesia ranged from 53 to 74% from the second molar to second premolar. For the IANB plus buccal infiltration and mock lingual infiltration, successful pulpal anesthesia ranged from 57 to 69% from the second molar to second premolar. For the IANB plus mock buccal infiltration and lingual infiltration, successful pulpal anesthesia ranged from 54 to 76% from the second molar to second premolar. There was no significant difference ($P > .05$) in anesthetic success between the IANB plus buccal or lingual infiltrations and the IANB plus mock buccal infiltration and mock lingual infiltration. We conclude that adding a buccal or lingual infiltration of 1.8 mL of 2% lidocaine with 1:100,000 epinephrine to an IANB did not significantly increase anesthetic success in mandibular posterior teeth.

Key Words: Buccal infiltration; Inferior alveolar nerve block; Lidocaine; Mandibular posterior teeth.

INTRODUCTION

The inferior alveolar nerve block (IANB) is the most frequently used injection technique for achieving local anesthesia for mandibular restorative and surgical procedures. However, the IANB does not always result in successful pulpal anesthesia.[1–17] Failure rates of 7 to 75% have been reported in experimental studies.[1–17] Therefore, it would be advantageous to improve the success rate of the IANB.

Meechan et al[18] have shown that buccal or buccal plus lingual infiltrations of 1.8 mL of 2% lidocaine with 1:100,000 epinephrine were effective (obtaining 2 consecutive 80 readings with the electric pulp tes-

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ter) 32 to 39% of the time for pulpal anesthesia in adult mandibular first molars. Kanaa et al[19] also used a cartridge of 2% lidocaine with 1:100,000 epinephrine for buccal infiltration anesthesia of the mandibular first molar. The lidocaine solution had a 39% success rate (obtaining 2 consecutive 80 readings with the electric pulp tester). Obviously, the low success rate with the lidocaine solution would not allow profound pulpal anesthesia for most clinical procedures.

Because there was some anesthetic effect of the lidocaine solution for buccal and lingual infiltrations, perhaps adding a buccal or lingual infiltration to an inferior alveolar nerve block would result in a greater incidence of pulpal anesthesia. The purpose of this prospective, randomized, single-blind, crossover study was to compare the degree of pulpal anesthesia obtained with either a buccal or lingual infiltration of 1.8 mL of 2% lidocaine with 1:100,000 epinephrine following an inferior alveolar nerve block in mandibular posterior teeth.

METHODS

Forty-nine adult subjects participated in this study. The subjects were in good health and were not taking any medications that would alter their perception of pain. The Ohio State University Human Subjects Review Committee approved the study, and written informed consent was obtained from each subject.

The 49 blinded subjects randomly received 3 sets of injections: an IANB plus a mock buccal and a mock lingual infiltration of the mandibular first molar, an IANB plus a buccal infiltration, and a mock lingual infiltration of the mandibular first molar, and an IANB plus a mock buccal infiltration and a lingual infiltration of the mandibular first molar in 3 separate appointments spaced at least 1 week apart, in a crossover design. All subjects received IANB injections using 3.6 mL of 2% lidocaine with 1:100,000 epinephrine (Xylocaine, Astra Pharmaceutical Products Inc, Worchester, Mass). We chose to use a 3.6 mL volume to see if success of the IANB could be improved. However, at the time of the study we did not have the results of a study showing no difference in success with either a 1.8 mL or 3.6 mL volume of lidocaine.[12] The infiltration injections used 1.8 mL of 2% lidocaine with 1:100,000 epinephrine. With the crossover design, there were 147 total sets of IANBs plus infiltrations administered, and each subject served as his/her own control. Twenty-five sets of IAN/infiltration injections were administered on the right side and 24 sets of injections were administered on the left side. The same side randomly chosen for the first set of injections was used again for the second and third sets of injections. The test teeth chosen for the experiment were the first and second molars and the first and second premolars. The contralateral canine was used as the unanesthetized control to ensure that the pulp tester was operating properly and that the subject was responding appropriately during each experimental portion of the study. Clinical examinations indicated that all teeth were free of caries, large restorations, and periodontal disease; none had histories of trauma or sensitivity.

Under sterile conditions, the lidocaine solution for the IANB was prepared by placing 3.6 mL of 2% lidocaine with 1:100,000 epinephrine, from standard anesthetic cartridges, into a sterile 5-mL disposable syringe (Leur-Lok, Dickinson and Co, Rutherford, NJ) each day of the appointment. For the infiltration injections, 1.8 mL of 2% lidocaine with 1:100,000 epinephrine were administered using a standard cartridge and an aspirating syringe equipped with a 27-gauge 1¼-inch needle. All lidocaine cartridges were checked to ensure that the anesthetic solution had not expired.

Before the experiment, the 3 sets of injections were randomly assigned 4-digit numbers from a random number table. Each subject was randomly assigned to each of the three sets of injections to determine which injection set was to be administered at each appointment. Only the random numbers were recorded on the data collection sheets to further blind the experiment.

At the beginning of each appointment and before any injections were given, the experimental teeth and control contralateral canine were tested 2 times with the pulp tester (Kerr, Analytic Technology Corp, Redmond, Wash) to record baseline vitality. After the tooth to be tested was isolated with cotton rolls and dried with gauze, toothpaste was applied to the probe tip, which was then placed midway between the gingival margin and the occlusal edge of the tooth. The current rate was set at 25 seconds to increase from no output (0) to the maximum output (80). The number associated with the initial sensation was recorded. Trained research personnel performed all preinjection and postinjection tests.

A standard inferior alveolar nerve block[20] was administered with a 27-gauge 1¼-inch needle (Monoject, Sherwood Services, Mansfield, Mass) using 3.6 mL of 2% lidocaine with 1:100,000 epinephrine in a 5 mL syringe equipped with an aspirating handle (Becton-Dickinson & Co, Rutherford, NJ).

At 3 minutes after completion of the IANB, a mock infiltration injection was administered either on the buccal or lingual aspect of the mandibular first molar. Whether the buccal or lingual mock injection was given was predetermined by the random order for the set of injections administered. The mock injection used a standard syringe equipped with a 27-gauge needle that was bent over within the syringe so it would not engage the rubber diaphragm of the cartridge. The needle was gently inserted into the unattached alveolar mucosa and the needle was held in place for 1 minute to mimic an infiltration. All subjects were instructed to close their eyes during administration of the mock infiltration.

At 6 minutes after the completion of the IANB, a mock infiltration or either a buccal or lingual infiltration was administered. For the buccal infiltration, the injection was administered buccal to the mandibular first molar bisecting the approximate location of the mesial and distal roots. A standard aspirating syringe and cartridge of 1.8 mL of 2% lidocaine with 1:100,000 epinephrine were used. A sterile rubber stopper was placed on the 27-gauge needle 21 mm from the tip. With the bevel of the needle facing bone, the needle was gently placed into the alveolar mucosa and advanced slowly until the stopper approximated the height of the buccal cusp tips of the first molar. The anesthetic solution was deposited over a period of 1 minute. For the lingual infiltration, the injection was administered into alveolar mucosa just below the most apical extent of the lingual attached gingiva adjacent to the first molar. The tongue was displaced medially with a mouth mirror to improve visibility. The anesthetic solution was deposited over a period of 1 minute. All subjects were instructed to close their eyes during administration of the infiltration. All IANB and infiltrations injections were given by 1 operator (WF).

One minute after completion of the infiltration (8 minutes after the IANB), the first and second molars were pulp tested. At 9 minutes after the IANB, the first and second premolars were tested. At 11 minutes after the IANB, the control canine was tested. This cycle of testing was repeated every 3 minutes. At every fourth cycle the control tooth, the contralateral canine, was tested by a pulp tester without batteries to test the reliability of the subject. Trained research personnel performed all pulp testing. Each subject was asked if his or her lip was numb every minute beginning at 3 minutes after completion of the IANB block. If profound lip numbness was not recorded within 6 minutes, the block was considered unsuccessful and the subject was reappointed. All testing was stopped at 60 minutes postinjection.

No response from the subject at the maximum output (80 reading) of the pulp tester was used as the criterion for pulpal anesthesia. Anesthesia was considered successful when 2 consecutive 80 readings were obtained within 15 minutes, and the 80 reading was continuously sustained for 60 minutes. Clinically, for most restorative procedures we would desire satisfactory patient anesthesia to start within 15 minutes of injection and to last for 60 minutes.

Comparisons of anesthetic success between the IANB plus mock buccal infiltration and mock lingual infiltration and IANB plus mock lingual infiltration plus buccal infiltration; and between IANB plus mock buccal infiltration and mock lingual infiltration and IANB plus mock buccal infiltration plus lingual infiltration were analyzed nonparametrically using Exact McNemar tests. Incidences of pulpal anesthesia (percentage of 80 readings across time) between the 3 sets of injections were analyzed using Exact McNemar tests. Comparisons were considered significant at $P < .05$.

RESULTS

Forty-nine adult subjects, 28 women and 21 men, age 19 to 48 years with an average age of 25 years, participated.

One hundred percent (49 of 49) of the subjects used for data analysis had profound lip anesthesia with all sets of IANB injections. The rates of anesthetic success are presented in the Table. For the IANB plus mock buccal infiltration and mock lingual infiltration, successful pulpal anesthesia ranged from 53 to 74% from the first premolar to second molar. For the IANB plus mock lingual infiltration plus buccal infiltration, successful pulpal anesthesia ranged from 57 to 69%. The success rate for the IANB plus mock buccal infiltration plus lingual infiltration ranged from 54 to 76%. There were no significant differences between the IANB plus mock injections and the IANB plus the active infiltrations. Figures 1 through 4 present the incidence of pulpal anesthesia (80 readings) for the 3 sets of injections. The only significant differences ($P < .05$) were shown at minutes 13, 17, and 25 when the IANB plus mock buccal infiltration and mock lingual infiltration was compared with the IANB plus mock lingual infiltration plus buccal infiltration for the first premolar (Figure 4).

DISCUSSION

We based our use of the pulp test reading of 80—signaling maximum output—as a criterion for pulpal anesthesia on the studies of Dreven and colleagues[21] and Certosimo and Archer.[22] These studies[21,22] showed that no patient response to an 80 reading ensured pulpal anesthesia in vital asymptomatic teeth. Addi-

Percentages and Number of Subjects Who Experienced Anesthetic Success

	Anesthetic Technique		
*Anesthetic Success**	*IANB*	*IANB Plus Buccal Infiltration*	*IANB Plus Lingual Infiltration*
Second molar	74% (36/49)	69% (34/49)	76% (37/49)**
First molar	53% (26/49)	57% (28/49)	61% (30/49)**
Second premolar	66% (29/44)	66% (29/44)	54% (24/44)**
First premolar	56% (24/43)	67% (29/43)	61% (26/43)**

* Some teeth were missing from the 49 subjects due to extractions for orthodontic treatment.
** There were no significant differences ($P > .05$) between the IANB and IANB plus buccal infiltration and IANB plus lingual infiltration.

tionally, Certosimo and Archer[22] demonstrated that electric pulp test readings *less* than 80 resulted in pain during operative procedures in asymptomatic teeth. Therefore, using the electric pulp tester prior to beginning dental procedures on asymptomatic vital teeth will provide the clinician a reliable indicator of pulpal anesthesia. Because all subjects felt profound lip numbness, but pulp testing revealed that subjects did not always have pulpal anesthesia (80 readings), asking the patient if the lip is numb only indicates soft-tissue anesthesia but does not guarantee successful pulpal anesthesia.

For all teeth, anesthetic success (Table) and incidence of pulpal anesthesia (Figures 1 through 4), were not significantly different between the IANB plus mock buccal infiltration and mock lingual infiltration and the IANB plus mock buccal infiltration plus lingual infiltration. Apparently, not enough of the anesthetic solution gained access through the bone on the lingual aspect of the mandible when the lingual infiltration was added to an IANB block. Meechan and co-authors[18] found that buccal plus lingual infiltrations of 1.8 mL of 2% lidocaine with 1:100,000 epinephrine (0.9 mL was administered on the buccal and 0.9 mL on the lingual) were effective (obtaining 2 consecutive 80 readings with the electric pulp tester) 32% of the time in adult mandibular first molars. In the current study, the lingual infiltration contributed little to first molar anesthesia after an IANB (Figure 2). The other aspect of an infiltration on the lingual of the first molar would be the contribution of the mylohyoid nerve to first molar anesthesia.[23] If the mylohyoid nerve contributed to failure of first molar anesthesia, an infiltration of 1.8 mL of a lidocaine solution would be expected to significantly increase the success of the IANB. Because this did not occur in this study, it is unlikely that the mylohyoid nerve contributes significantly to posterior teeth innervation. Clark and coauthors[8] studied the contribution of the mylohyoid nerve to mandibular pulpal anesthesia and found no significant support for an active role of the mylohyoid nerve in pulpal anesthesia.

The contribution of the buccal nerve to pulpal anesthesia should be minimal. Further study of the contribution of the combination IANB plus long buccal nerve block to pulpal anesthesia requires further

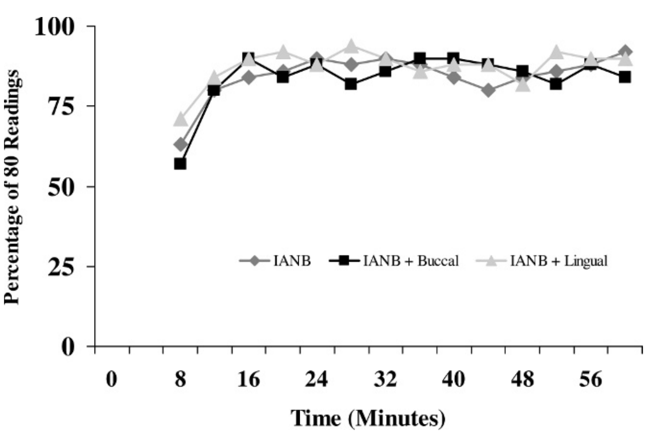

Figure 1. Incidence of second molar anesthesia as determined by lack of response to electrical pulp testing at the maximum setting (percentage of 80/80s), at each postinjection time interval, for the 3 sets of injections. There were no significant differences ($P > .05$) among any of the 3 sets of injections.

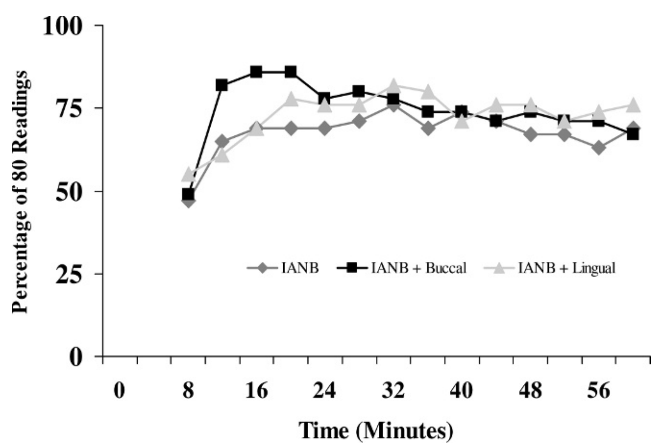

Figure 2. Incidence of first molar anesthesia as determined by lack of response to electrical pulp testing at the maximum setting (percentage of 80/80s), at each postinjection time interval, for the 3 sets of injections. There were no significant differences ($P > .05$) among any of the 3 sets of injections.

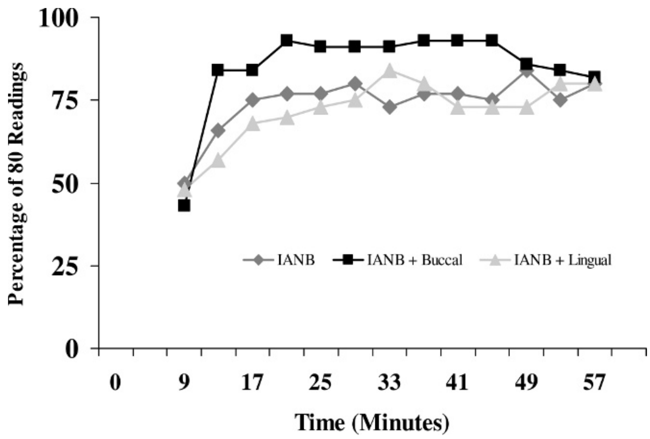

Figure 3. Incidence of second premolar anesthesia as determined by lack of response to electrical pulp testing at the maximum setting (percentage of 80/80s), at each postinjection time interval, for the 3 sets of injections. There were no significant differences ($P > .05$) among any of the 3 sets of injections.

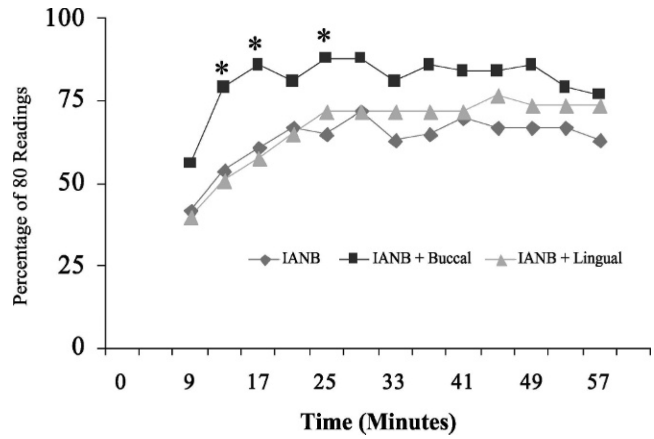

Figure 4. Incidence of first premolar anesthesia as determined by lack of response to electrical pulp testing at the maximum setting (percentage of 80/80s), at each postinjection time interval, for the IANB versus the IANB plus lingual infiltration. Significant differences ($P < .05$) between the IANB versus the IANB plus buccal infiltration are marked with an asterisk (*).

study. However, it is unlikely that a long buccal nerve block would be superior to the IANB plus buccal infiltration in the current study.

When comparing anesthetic success (Table) for the IANB plus mock buccal infiltration and mock lingual infiltration versus IANB plus mock lingual infiltration plus buccal infiltration, there were no significant differences for any of the teeth. However, in evaluating Figures 2 through 4 and the incidence of anesthesia, there was a slight increase in anesthesia initially for the first molar and higher values for the first and second premolars. Only 3 times (13, 17, and 25 minutes) was significance reached for the first premolar (Figure 4). Meechan et al[18] showed a primary buccal infiltration of 1.8 mL of 2% lidocaine with 1 : 100,000 epinephrine resulted in a success rate (obtaining 2 consecutive 80 readings with the electric pulp tester) of 39% for pulpal anesthesia of the first molar. Kanaa et al[19] reported a similar success rate in another study of mandibular first molar buccal infiltration using a lidocaine solution. Our results would support the studies of Meechan et al[18] and Kanaa et al[19] that a buccal infiltration of a lidocaine solution has some effect on pulpal anesthesia. However, the success rate was not significantly increased. Based on the studies by Meechan et al[18] and Kanaa et al[19] and the current study, a buccal infiltration of 1.8 mL of 2% lidocaine with 1 : 100,000 epinephrine after an inferior alveolar nerve block would not result in profound pulpal anesthesia of the posterior teeth.

Even when using a 2 cartridge volume, the IANB plus mock buccal infiltration and mock lingual infiltration had similar rates of anesthetic success and incidence of pulpal anesthesia as other studies of the IANB.[1–17] Naturally, some variations in success would be expected in studies[1–17] because of population differences and differences in definition of success. The IANB did not provide complete pulpal anesthesia for the mandibular posterior teeth (Figures 1 through 4) and could present meaningful clinical problems since the teeth may not be numb for procedures requiring complete pulpal anesthesia. Practitioners should consider supplemental techniques, such as intraosseous[24–32] or periodontal ligament injections[33,34] when an IANB fails to provide pulpal anesthesia for a particular tooth. Because we studied a young adult population, the results of this study may not apply to children or the elderly.

Kanaa et al[19] compared a cartridge of 2% lidocaine with 1 : 100,000 epinephrine to 4% articaine with 1 : 100,000 epinephrine for buccal infiltration anesthesia of the mandibular first molar. The articaine solution had a significantly higher success rate (obtaining 2 consecutive 80 readings with the electric pulp tester) of 64% when compared to the lidocaine solution—a 39% success rate. Perhaps, adding a buccal or lingual infiltration of an articaine solution to an inferior alveolar nerve block would increase pulpal anesthesia for the posterior teeth in the mandible.

CONCLUSION

In conclusion, adding a buccal or lingual infiltration of 1.8 mL of 2% lidocaine with 1 : 100,000 epinephrine to an IANB did not significantly increase anesthetic success in mandibular posterior teeth.

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